A Novel Formula to Predict Tooth Eruption Patterns in Pediatric Patients

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Problem

Currently there is no standardized method to determine whether a pediatric patient's dental development is advanced or delayed. While there is significant information available regarding the typical sequence of eruption for various types of teeth, based on large scale observation[1], there has been no validated, evidence based model for the typical number of erupted teeth at any given age. This gap exists because no comprehensive data has been collected on this subject, nor has there been any quantitative evaluation of it. The eruption timelines are broad, making it challenging to determine an individual's precise dental age. As a result, there is no well-defined criteria to classify a pediatric patient's dental development as advanced or delayed, and it can therefore be difficult to address the concerns of patients and parents regarding the normal progression of the eruption sequence. The primary objective of this research is to develop and validate a novel mathematical formula capable of predicting the number of permanent teeth in patients aged 6 to 12 years based on their age.

In order to create a clear distinction between patients with advanced or delayed dental development, an empirical guideline is required. Historically, the dental field has incorporated mathematical data to support diagnosis and treatment planning. For example, studies such as Mathematical Tooth Proportions: A Systematic Review (Akl, 2022) in the Journal of Prosthodontics[2] demonstrate the ongoing demand for predictable mathematical ratios and formulas that can contribute to aesthetic clinical outcomes. One notable formula, Tanaka and Johnston's analysis[3] predicts the available space for the eruption of permanent teeth. Yet, no mathematical model has been developed to predict the exact number of permanent teeth that will emerge at a given age during the mixed dentition period.

Solution

The mixed dentition period, which spans from around the age of 6 to 12, is characterized by the eruption of permanent teeth while the primary teeth are still present. This transitional phase is crucial for dental professionals, especially predoctoral students, who often struggle to learn the eruption patterns and sequences due to their broad and variable nature. Recognizing this challenge, here we propose a hypothetical formula to predict the number of permanent teeth during this period:

Number of Permanent Teeth (y) = 4 × (Age in years (x) − 5)

Alternatively, when age is measured in months, the formula could be written as: y= ⅓ x - 20
This research aims to validate this formula in accurately predicting the number of permanent teeth by using data collected from 100 patient records from the Pediatric Clinic at the UNLV School of Dental Medicine.

Patients, aged between 6 and 12, were randomly selected from radiographs taken during recall exams at the University of Nevada, Las Vegas, School of Dentistry, Pediatric dental clinic between July and September, 2024. The radiographs included periapical X-rays, bitewing films, and panoramic radiographs, which were used to determine the number of erupted permanent teeth. A tooth was considered to have erupted if any part of it had broken through the gingiva. For example, in Figure 1, the upper central incisors were marked as erupted, while the upper lateral incisors were considered unerupted because they were still covered under the gum.

Figure 1. Periapical x-ray showing upper right lateral is still covered in gingiva while upper right central is barely erupted

Results

To analyze the relationship between the number of permanent teeth and patient age, a dataset of 100 samples was compiled. These samples were plotted with the number of permanent teeth on the y-axis and the patient's age in months on the x-axis as shown in Figure 2. A linear regression analysis was performed to determine the best-fit line for the data. The resulting equation was:

$y=0.3024x-17.847$, $R^2 = 0.7979$

The coefficient of determination (R^2) for this regression was found to be 0.7979, indicating a strong linear relationship between the patient's age and the number of erupted permanent teeth. This result suggests that age is a reliable predictor of the number of permanent teeth present. This high R^2 value signifies a good linear fit for the model.

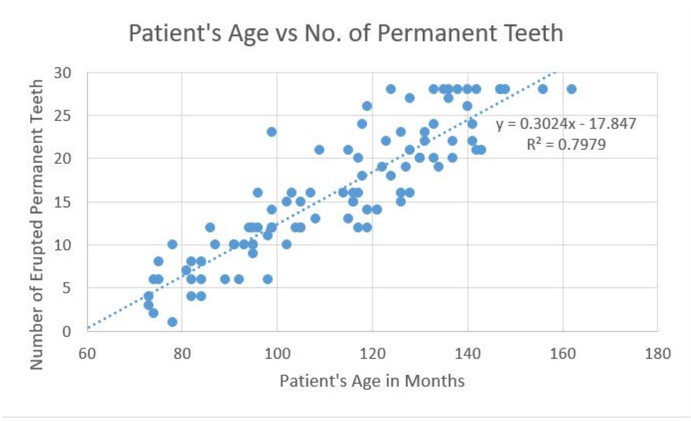

Figure 2 Graph showing the linear relationship between patient's age and number of permanent teeth.

For educational purposes and to simplify the formula, the equation can be expressed as:

Y= 3/10 X − 18

Where Y represents the predicted number of erupted teeth and X represents the patient's age in months. The linear relationship shows that the permanent tooth eruption is unaffected by growth spurts. Using this equation, one can make clinical and age-based predictions that can help categorize patients as dentally advanced or delayed.

In conclusion, the findings of this study contribute to the field of pediatric dentistry by providing a mathematical model that predicts the number of permanent teeth based on age. This model can assist in clinical decision-making, allowing for more accurate assessments of dental development. The model can be further refined by incorporating additional variables such as gender or genetic factors to enhance its precision and applicability across diverse patient populations.

References

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